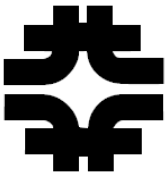

Fermilab

PIP-II
PXIE MEBT Allison Emittance Scanner
Functional Requirements Specification

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Revision History

Revision	Date	Section No.	Revision Description
0	08/20/2015	ALL	Initial Draft

Introduction and scope

The specification describes requirements for PXIE MEBT Allison emittance scanner (MAES) intended for measuring a single plane (horizontal or vertical) of transverse emittance of beam in the MEBT. The MAES is an insertion device that scans across the beam both in position and angle. The output of this scan produces a transverse phase-space portrait. The MAES is similar in operation and design to the PXIE LEBT Allison emittance scanner.
The MAES can only be used with short beam pulses to avoid damaging of the front slits. Water cooling can be provided to the front slits to improve the thermal stability.

Relevant beam parameters

For the purpose of the MAES measurements, the beam is assumed coming in trains (pulses) of 162.5 MHz bunches with parameters indicated in Table 1.

Table 1. Relevant beam parameters

Parameter	Unit	Nominal value	Range
Particles type		H^-	
Energy	MeV	2.1	2.0 – 2.2
Bunch frequency	MHz	162.5	
Nominal pulse repetition rate	Hz	60	1 - 60
Nominal pulse length	μs	20	5 - 50
Current averaged over 1 μs	mA	5	1 - 10
rms beam radius	mm	2	1 – 4
Beam angular spread, rms	mrad	1.5	0.5 - 3

MAES functional requirements

For the range of beam parameters listed in Table 1, the MAES should provide time-resolved transverse phase space plot with calculated RMS emittance and Twiss parameters. The phase space plot should allow measuring of at least ±3 rms of the maximum radius (i.e. ±12 mm) and maximum angle (i.e. ±9 mrad).
The calculated error in the emittance resulted from the finite slit size should not exceed 2%.
Time slice resolution should be at least 1 μs. Results for longer time slices are reported as the averages over the slice.

The MAES must have the capability of being mounted both horizontally and vertically.
The design should be compatible with UHV environment. Vacuum chamber and stand must allow for MAES sensor pitch adjustment under vacuum.

Interfaces

Table 2. Mechanical interfaces for the MAES monitor

Parameter	Unit	Value
Longitudinal space, flange-to-flange	mm	≤ 450
Clear aperture of vacuum chamber with fully retracted monitor	mm	≥ 30
Matching flanges		CF 2 ¾

Recommended technical parameters

Table 3. Recommended technical parameters of the MAES, including electronics. The Table assumes a vertical scan orientation of the monitor.

Parameter	Unit	Value
Motion and positioning		
Vertical range of measurement positions with respect to the beam line axis	mm	± 15
Absolute accuracy of vertical position of the sensor	mm	≤ 1
Reproducibility of vertical position	mm	≤ 0.1
Resolution of vertical position	mm	≤ 0.025
Sensor horizontal alignment with respect to beam line axis	mm	≤ 1
Sensor yaw alignment with respect to beam line axis	mR	10
MAES module pitch adjustment range	mR	± 35
MAES module pitch adjustment resolution	mR	1
MAES module pitch angle stability thru measurement region	mR	0.2
Scanner dimensions		
Scanner slit-to-slit distance	mm	320
HV deflector plate length	mm	300
Minimum HV deflector plate width	mm	> 40
Gap between teeth on HV plates	mm	5.5 ±0.2*
Angle of the teeth surface on HV plates	degree	> 2
Teeth depth	mm	≤ 0.5
Front slit gap	mm	0.2
Rear slit gap	mm	0.2
Front slit/Rear slit/HV plates axial alignment	mm	< 0.2
Electric		
HV amplitude on each plate	kV	-1 to +1
Time Slice Resolution	μS	1

*The surfaces of opposite plates should be parallel within ±0.1 mm along all length. The design should provide capability to measure the distance between teeth of opposite plates in at least one location at 0.05 mm precision.

REFERENCES

1. PXIE Functional Requirements Specification, TC # ED0001223, uncontrolled copy is available at http://projectx-docdb.fnal.gov/cgi-bin/ShowDocument?docid=980
2. MEBT Functional Requirements Specification, TC# ED0001303, uncontrolled copy is available at http://projectx-docdb.fnal.gov/cgi-bin/ShowDocument?docid=938